UAH
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Research Administration

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June 11, 1998

U.S. Army Aviation & Missile Command
SFAE-MSL-ML-TR-P
Attn: Mr. Joel Price
Redstone Arsenal, AL 35898

RE: Final Report
DAAH01-91-D-R002 D.O. 108

Dear Mr. Price:

Please find enclosed a copy of the above noted **Final Report** for "Atmospheric Model Development for MLRS" as required by the above referenced contract.

If you have any questions or need additional information, please contact me at (256) 890-6000 ext. 224.

Sincerely,

Kimberly R. Horvath

Kimberly R. Horvath
Contract Assistant

ENC.

cc:	AMSAM-AC-RD-BB/Belva Lynn	(ltr/rpt)
	ONRRO	(ltr/rpt)
	DTIC/OCA	(2 ltr/rpt)
	UAH/O. Essenwanger	(ltr)
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19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This report is divided into 5 letter reports covering the required scope of work tasks.

The first task was the determination of the frequency distribution of 2, 3, and 4 m/sec wind speed at the surface, 199 and 1000 m elevation for 2 Korean stations (Tab;es 108 -1.1 and 1.2). Tables 108 - 1.3 to 1.5 display the conditions for the same thresholds for other climatic regimes, standardized here. We learn that the Korean stations have much weaker wind speeds than at these previous stations.

The next ketter report delineates the study of the wind direction turn angle from the surface to 300m 500, 1000, amd 1500 m of elevation. Of special interest was the 300 m elevation. Table 108-2.1 illustrates the turn angle. The turn angle from zero to 45 degrees implies agreement with the "Eknan Model" of friction. It is not surprising, however, that Albrook in the tropics provides the highest frequency with almost 85 % of data in

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
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this range, Thule shows the smallest amount. This is caused that cold air advection leads to backing, while friction and warm air advection shows veering of the wind. Thus cold air advection is expected to be low in the tropics (Albrook), while it is highest at the polar station (Thule). Similar results can be found fpr the additional tabulations 108 - 2.3 to 2.11.

In letter report # 3 the wind direction profile is presented which is associated with the exdeedance kevel of the wind speed. It should be noticed that the exceedance levels in the heading of the Tables 108 - 3.1 - 3.4 are not exceedance levels for the wind direction but rather the associated mean profile direction for the wind speed profiles. We learn that the strong winds disclose a shift of the wind direction towards easterlies in the tropics, towards westerlies in the other regions. E.g. strong windsmat change from a headwind to a lateral wind if the mean direction profile for the year is used for strong winds. It is cautioned that a wind speed profile at the 99 % exceedance level is higher in 1 % of the cases.

Although the next task was uniform in the technical aspect of the requirement. The regions for the wind speed profiles comprise two different climatic regimes. Thus the task was divided into letter report 4 abd 5, The first report deals with the Middle East, report # 5 covers the Skandinavian area.

In the Middle East Dhahran, Abu Dhabi, and Rhyadh delineate a similar climatic regime while Israel has muchg stronger winds.

The Skandinavian stations resemble wind speed profiles for Berlin (Kopenhavn and Oslo) and Thule (Jan Mayen). Details may be found in Tables 108 - 4.1 - 4.4 (Middle East) and Tables 108 - 5.1 to 5.3 (Skandinavia).

In addition to the wind speed profiles for exceeance levels ranging from 50 to 99 % the wind direction profiles are given for the year, winter, and summer. It should be noticed that in the higher elevations the summer mean directional profile is quite different from winter.

Finally, the principal investigator attended the Conference on Atmospheric Battle Space which was held at the Navy facility at San Diego. California. Discussions centered on the results from the study of the Ekman Model, and tentative results from wind speed profiles for the Middle East.

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MONTHLY TECHNICAL PROGRESS

Report No. FARMY 108.98

FOR THE PERIOD OF: 7/21/1997 to 3/30/98 PREPARED: Dr. Oskar Essenwanger

Contract No.: DAAH01-91-D-R002	Delivery Order No.: 108
Delivery Order Title: Atmospheric Model Development for MLRS	
Research Activities Performed: Development of Wind Profile of Probability of Exceedance. Study of Ekman Model for various Elevations.	
Problems Encountered: Some problems in preparing data from pressure levels to km levels (metric)	
Research Activities Planned Next Month: contract expired 31 March 98	
Dr. Oskar Essenwanger Principal Investigator	Date:
Prepared for: ______ ATTN: ______	cc:

TPR/RA88

Attachments can be appended

Encl. #1

REPORT FARMY108.98

DAAH01-91-D-R002DO 108

Sequence Number A008

15 May 1998

Principal Investigator

Dr.Oskar Essenwanger

Prof. Atmosph. and Emvironm. Science

TABLE OF CONTENT

DAAH01-91-D-R002
PAN R32-07-7
D/O 108

STATEMENT OF WORK
Atmospheric Model Development for MLRS
5 JUNE 97

Section I. Background and Objective

The Aerodynamics Technology Functional Area of the Systems Simulation and Development Directorate of the U.S. Army Missile Command is providing support to the Multiple Launch Rocket System (MLRS) Project Office in the area of aerodynamic and atmospheric model development. The objectives of this task shall be to enhance atmospheric wind models for specific terrain and climatic regimes.

Section II. Requirements

1. The contractor shall determine the frequency of windspeed under 2 m/sec and 3 m/sec at surface and 100 meters above the surface for two Korean stations, and compare these with the global data provided in latter report FARMY-86-1,95.

2. The contractor shall provide frequency distributions of the turn angle in the Ekman spiral model for three stations (Berlin, Albrook, Thule or government approved substitution). Of special interest is the turn angle in the boundary layer (surface to 500 meters).

3. The contractor shall develop mean wind direction profiles for 4 significant climatic regimes associated with the 50, 84, 90 and 99 percent exceedance windspeed profiles described in the final report FARMY-43. These profiles will include summer conditions (June, July, August).

4. The contractor shall develop wind velocity profiles using the methods described in FARMY-153 for locations representative of Bahrain, Israel, Norway, and Denmark. These profiles shall be based on historical data and shall include 50, 68, 84, 90, and 99 percent profiles.

5. Results from this analysis shall be presented and discussed with personnel of the Battlefield Directorate, White Sands, NM.

ABSTRACT.

This report is divided into 5 letter reports covering the required scope of work tasks.

The first task was the determination of the frequency distribution of 2, 3, and 4 m/sec wind speed at the surface, 199 and 1000 m elevation for 2 Korean stations (Tab;es 108 -1.1 and 1.2). Tables 108 - 1.3 to 1.5 display the conditions for the same thresholds for other climatic regimes, standardized here. We learn that the Korean stations have much weaker wind speeds than at these previous stations.

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In addition to the wind speed profiles for exceeance levels ranging from 50 to 99 % the wind direction profiles are given for the year, winter, and summer. It should be noticed that in the higher elevations the summer mean directional profile is quite different from winter.

Finally, the principal investigator attended the Conference on Atmospheric Battle Space which was held at the Navy facility at San Diego. California. Discussions centered on the results from the study of the Ekman Model, and tentative results from wind speed profiles for the Middle East.

Letter Report 108 - 1 15 May 1998

This letter report provides information about the cumulative frequency distribution of 2,3,and 4 m/sec of the wind speed at 3 elevations for two stations in Korea. For convenience 3 more thresholds have been added.

Table 108 - 1.1. illustrates the cumulative frequency of the wind speed for the required thresholds 2,3, and 4m/sec for Osan (Table 108 -1.1) and Yable 108 - 1.2 gives the same information for Pyong, both Kprea.

These tables are also including the threshold 5, 15, and 30 m/sec. and the maximum wind speed.

Three elevations, surface, 100 m, and 1 km were specified by the scope of work.

The same cumulative frequency of the wind speed is displayed in Tables 108 -3,4, and 5 for 5 stations from South to North. Although this information was provided in an earlier report (FARMY-DO -97). The tables have been standardized in the format of the Korean stations to permit an easy comparison.

We learn from Tables 108 - 1.1 and 1.2 that the surface wind speed at these Korean stations is lower or equals 2 m/sec for Osan and Pyong in 74 and 82 %, respectively. In comparison, the highest frequency is found (Table 108 - 1.3) at Thule wit about 57%. Although this frequency for the Korean stations appears to be very high, a comparison of the maximum wind speed in Table 108 -1.3 shows that the maximum at Pyong is in line with Montgomery or Trappes (France). Thus the Kprean data are reasonable.

The cumulative frequency of the wind speed at the other thresholds can be found by a closer perusal of the tables.

For the elevation of 100 m the frequency of a wind speed lower or equal to 2 m/sec reduces to 59 and 72 % for Osan and Pyong, respectively. This is in line with expectations, because the wind speed increases with height. Again, the highest frequency (Table 108 -1.4) for Thule with 57 %.

Finally, at 1 km we find the cumulative frequency for the 2 m/sec threshold with 9 and 11 % for Osan and Pyomg, respectively. Surprisingly the frequwncy is twicw as high for 2 m/sec at Thule (Table 108 -1.5). This indicates again that the result from the Korean data is reasonable.

The results for the other thresholds are depicted in the respective tables.

The tables have been furnished to the MLRS system upon reqyest on computer disks.

1,1 Windspeed Frequency Distribution for Osan, Korea

	surface		100 m		1 km	
d	N	%	N	%	N	%
ec	5969	74.1	4654	57.9	716	8.8
ec	6864	85.2	5923	73.7	1609	19.7
ec	6906	85.7	6757	84.1	2283	28.0
ec	7325	90.9	7209	89.7	3167	38.5
ec	8052	899.9	8026	99.9	7702	94.3
ec	8056	100.0	8032	100.0	8167	100.0
ec	8059	100.0	8034	100.0	8168	100.0

eed 41.2 m/sec 38.7 m/sec 30.3 m/sec

record 1973 - 1995

8 1,2 Windspeed Frequency Distribution. for PYong, Korea

n	surface		100 m		1 km	
ed	N	%	N	%	N	%
sec	10396	82.1	8427	71.9	1271	10.7
sec	11278	89.1	6939	82.2	2557	21.6
sec	11767	92.9	10446	89.1	4020	33.9
sec	12104	95.6	10921	93.2	5492	46.3
sec	12651	99.99	11713	99.9	11685	98.5
sec	12660	100.0	11722	100.0	11855	100.0
sec	12662	100.0	11723	100.0	11860	100.0

speed 40.0 m/sec 36.9 m/sec 71.6 m/sec

f record 1973 - 1996

5.0 m/s	2123	58.3	11889	84.1	[illegible]						
15.0 m/s	3642	99.9	13976	99.8	14993	99.8	4565	99.8	[illegible]	-	99.8
30.0 m/s	3644	100.0	13981	99.9	15005	99.9	4572	100.0	2847	99.9	99.9
TOTAL:	3644	100.0	14001	100.0	15022	100.0	4572	100.0	2849	100.0	100.0
MAX SURF WS:	17.2m/s		63.0m/s		68.2m/s		20.4m/s		37.4m/s		

Period of record: Albrook, Canal Zone 4 Jan 74 - 15 Jan 76
Trappes, France 1 Jan 71 - 31 Dec 96
Thule, Greenland 1 Jan 71 - 31 Dec 96
Montgomery, AL 12 Nov 74 - 31 Dec 96
Berlin, Germany 1 Jan 71 - 31 Dec 93

Table 108-1.4

WIND SPEED DISTRIBUTION - 100M

Wind Speed	ALBROOK N	ALBROOK %	MONTGOMERY N	MONTGOMERY %	TRAPPES N	TRAPPES %	BERLIN N	BERLIN %	THULE N	THULE %	AVERAGE %
2.0 m/s	753	20.7	1778	12.7	3119	20.8	402	8.8	1329	46.6	22.0
3.0 m/s	1232	33.8	6475	46.2	6310	42.0	1068	23.4	1859	65.3	42.1
4.0 m/s	1687	46.3	9848	70.3	9148	60.9	1751	38.3	2173	76.3	58.4
5.0 m/s	2123	58.3	11889	84.1	11360	75.6	2477	54.2	2376	83.4	71.1
15.0 m/s	3642	99.9	13976	99.8	14993	99.8	4565	99.8	2837	99.6	99.8
30.0 m/s	3644	100.0	13981	99.9	15005	99.9	4572	100.0	2847	99.9	99.9
TOTAL:	3644	100.0	14001	100.0	15022	100.0	4572	100.0	2849	100.0	100.0
MAX SURF WS:	17.2m/s		63.0m/s		68.2m/s		20.4m/s		37.4m/s		

Period of record: Albrook, Canal Zone 4 Jan 74 - 15 Jan 76
Trappes, France 1 Jan 71 - 31 Dec 96
Thule, Greenland 1 Jan 71 - 31 Dec 96
Montgomery, AL 12 Nov 74 - 31 Dec 96
Berlin, Germany 1 Jan 71 - 31 Dec 93

Table 108 - 1.5

WIND SPEED DISTRIBUTION - 1KM

Wind Speed	ALBROOK N	ALBROOK %	MONTGOMERY N	MONTGOMERY %	TRAPPES N	TRAPPES %	BERLIN N	BERLIN %	THULE N	THULE %	AVERAGE %
2.0 m/s	353	9.7	1183	8.4	787	5.2	180	3.9	603	21.2	9.7
3.0 m/s	640	17.6	2482	17.7	1799	12.0	435	9.5	1065	37.4	18.8
4.0 m/s	775	21.3	3165	22.6	2382	15.9	636	13.9	1273	44.7	23.7
5.0 m/s	1121	30.8	4571	32.6	3643	24.3	979	21.4	1619	56.8	33.2
15.0 m/s	3618	99.3	12975	92.7	13028	86.7	3881	84.9	2737	96.1	92.0
30.0 m/s	3644	100.0	13991	99.9	14969	99.6	4564	99.8	2848	100.0	99.9
TOTAL:	3644	100.0	14001	100.0	15022	100.0	4572	100.0	2849	100.0	100.0
MAX SURF WS:	26.2m/s		33.5m/s		51.4m/s		35.5m/s		51.0m/s		

Period of record: Albrook, Canal Zone 4 Jan 74 - 15 Jan 76
Trappes, France 1 Jan 71 - 31 Dec 96
Thule, Greenland 1 Jan 71 - 31 Dec 96
Montgomery, AL 12 Nov 74 - 31 Dec 96
Berlin, Germany 1 Jan 71 - 31 Dec 93

Report 108 - 2 15 May 1998.

ɘtter report provides the frequency of the wind direction
ngle (Ekman Spiral) for 3 stations (Berlin, Albrook, Thule).
cial interest is the boundary ayer (surface to 300 m.

is study was performed with data furnished on CD Rom by the
onmental Technical Application Center of the Air Force
heville, N.C. The study required to determine the
ıency of the turn angle of the wind in the boundary
r, especially the lowest 300 m.
s reported earlier (FARMY-DO-97) the wind direction
s in the lower layers for 3 reasons:

a) surface friction (Ekman Spiral)
b) warm air advection (veering)
c) Cold air advection (backing)

terms veering or backing refer to the direction
the turn angle of the wind from surface to a soecifie4
ɜvation. In the friction layer this turn is considered
a concept called the Ekman Spiral.

Two facts must be considered in a frequency of the
rn angle. In the study of the wind from surface to
specified elevation one can notice that the direction
ıy not display a uniform turn up to a certain height.
n the Ekman Model it is considered that a uniform turn
xists until the so-called geostrophic wind is reached.
n our study it was decided to find the "top" height
whenever the direction reversed veering by more than
10 degrees.

A second fact is the discontinuity of the wind direction
at 360 degrees. E.g. a wind direction of 20 degrees
at 300 m and a surface wind direction of 309 degrees
would lead to a numerical value of - 320 degrees unless
the the discontinuity at 360 degrees is properly considered.
This leads to 40 degrees (see EssenWANGER, 1986),

After including these two points into our calculations
the Table 108 -2.1 was obtained. For the Ekman Spiral
the interval from 0 to 45 degrees is expectedt. We learn
that for Albrook almost 86 % fall into this range.
The frequency is 53 % for Berlin, but only 30 % for Thule.
Backing of the wind shows a frequency of 9 % for Albrook, 17 %
for Berlin,and 51 % for Thule. These numbers may indicate the
frequency of cold air advection. These numbers are quite
reasonable in accordance with thr general circulation of
the atmosphere. where one would expect more cold air
affecting Thule.

A second tabulation for 300 m elevation was established
(Table 108 - 2.2). In this table the data were not
counted whenever the first direction was backing. This
was considered not in line with the Ekman Spiral.
In this table the 15 degree intervals start with
zero degree turn. The cumulative frequency distribution
of the turn angle is added up from zero degrees. We notice
that Albrook has a cumulative frequency from 0 ro 45 degrees
of 99 %, Berlin 95 and Thule 84 %.

It was assumed that backing from surface on to the next available elevation is implying cold air advection. It must also pointed out that the positive turn angle includes che dases of warm air advection. The separation into the 3 groups causing the wind to turn may be an interesting but also beneficial study by itself.

The author realizes that the surface friction plays an important role in this statistical analysis as obtained here. It must be called to the attention that the result fits reasonably into the scheme of the general circulation. How much warm or cold air advection by overriding or enhancing the frictional effect. These effects could not be determined in the time frame of this study.

In an earlier report it was stated that the frictional boundary layer effect is found at a higher elevation in the tropics than at midlatitudes and polar areas. Thus 3 more tables each for all three stations were added (Tables 108 - 2.3 to 2.11) These tables were calculated for top heights up to 500, 1000, and 1500 m. They display the same trend as the previous tables. It must also be added that in these tables the direction profile was not terminated whenever the reversal of the principal directional turn was less than 10 degrees. This has lead to a reduction in the size of the turn angle compared with Tables 108 -2.1 and 2.2. Thus the frequency distribution for the same classes as in these tables delineates slight differences in the size of the turn angles.

Table 108 - 2.1 Turn of the Wind Direction between Surface and 300 m.
"ind direstion at 300m minus wind direction at surface.

Turn	ALBROOK #	ALBROOK %	ALBROOK Cum %	BERLIN #	BERLIN %	BERLIN Cum %	THULE #	THULE %	THULE Cum %
-166	1	0.1	0.1	2	0.0	0.0	97	0.9	0.9
-151	0	0.0	0.1	5	0.1	0.1	161	1.5	2.4
o -136	0	0.0	0.1	3	0.1	0.2	161	1.5	3.9
:o -121	0	0.0	0.1	7	0.1	0.4	210	1.9	5.8
to -106	0	0.0	0.1	13	0.3	0.6	204	1.9	7.7
to -91	0	0.0	0.1	14	0.3	0.9	230	2.1	9.8
to -76	0	0.0	0.1	21	0.4	1.4	311	2.9	12.7
to -61	0	0.0	0.1	35	0.7	2.1	397	3.7	16.4
to -46	3	0.4	0.5	80	1.7	3.8	576	5.3	21.7
5 to -31	4	0.5	1.0	221	4.7	8.6	768	7.1	28.8
0 to -16	12	1.6	2.6	537	11.5	20.1	1090	10.1	38.9
.5 to -1	69	9.1	11.7	816	17.4	37.5	1277	11.8	50.7
0 to 14	313	41.1	52.8	1161	24.8	62.3	1608	14.9	65.6
15 to 29	258	33.9	86.6	778	16.6	79.0	991	9.2	74.7
30 to 44	81	10.6	97.2	534	11.4	90.4	685	6.3	81.0
45 to 59	14	1.8	99.1	255	5.5	95.8	459	4.2	85.3
60 to 74	2	0.3	99.3	88	1.9	97.7	350	3.2	88.5
75 to 89	1	0.1	99.5	48	1.0	98.7	253	2.3	90.9
90 to 104	2	0.3	99.7	19	0.4	99.1	187	1.7	92.6
105 to 119	0	0.0	99.7	15	0.3	99.5	156	1.4	94.0
120 to 134	1	0.1	99.9	13	0.3	99.7	167	1.5	95.6
135 to 149	1	0.1	100.0	5	0.1	99.9	170	1.6	97.2
150 to 164	0	0.0	100.0	6	0.1	100.0	139	1.3	98.4
165 to 180	0	0.0	100.0	1	0.0	100.0	169	1.6	100.0
AL ALL CLASSES:	762			4677			10816		

Table 108 - 2.2 Wind Turn Between Surface and 300 m, no Backing included.

		ALBROOK			BERLIN			THULE		
Class	Wind Turn	#	%	Cum %	#	%	Cum %	#	%	Cum %
1	0	229	26.3	26.3	4957	59.5	59.5	7104	60.1	60.1
2	1 to 15	415	47.7	74.0	1762	21.1	80.7	1303	11.0	71.1
3	16 to 30	177	20.3	94.4	776	9.3	90.0	915	7.7	78.8
4	31 to 45	41	4.7	99.1	437	5.2	95.2	599	5.1	83.9
5	46 to 60	4	0.5	99.5	206	2.5	97.7	448	3.8	87.7
6	61 to 75	1	0.1	99.7	86	1.0	98.7	286	2.4	90.1
7	76 to 90	0	0.0	99.7	36	0.4	99.1	245	2.1	92.2
8	91 to 105	1	0.1	99.8	24	0.3	99.4	169	1.4	93.6
9	106 to 120	1	0.1	99.9	17	0.2	99.6	153	1.3	94.9
10	121 to 135	0	0.0	99.9	10	0.1	99.8	158	1.3	96.2
11	136 to 150	1	0.1	100.0	8	0.1	99.9	150	1.3	97.5
12	151 to 165	0	0.0	100.0	6	0.1	99.9	129	1.1	98.6
13	166 to 180	0	0.0	100.0	4	0.0	100.0	95	0.8	99.4
14	181 to 195	0	0.0	100.0	0	0.0	100.0	22	0.2	99.6
15	196 to 210	0	0.0	100.0	1	0.0	100.0	20	0.2	99.8
16	211 to 225	0	0.0	100.0	0	0.0	100.0	13	0.1	99.9
17	226 to 240	0	0.0	100.0	0	0.0	100.0	11	0.1	100.0
18	241 to 255	0	0.0	100.0	1	0.0	100.0	4	0.0	100.0
9	256 to 270	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
0	271 to 285	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
1	286 to 300	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
2	301 to 315	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
3	316 to 330	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
4	331 to 345	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
5	346 to 360	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TAL ALL CLASSES:			870			8331			11824	

Table 108 - 2.3 , WIND TURN, ALBROOK, CANAL ZONE.

Wind direction at top height minus wind direction at surface.

Class	Wind Turn	500 M #	500 M %	500 M Cum %	1000 M #	1000 M %	1000 M Cum %	1500 M #	1500 M %	1500 M Cum %
1	-180 to -166	1	0.2	0.2	2	0.3	0.3	3	0.4	0.4
2	-165 to -151	0	0.0	0.2	2	0.3	0.6	4	0.6	1.0
3	-150 to -136	2	0.3	0.5	2	0.3	0.9	2	0.3	1.3
4	-135 to -121	1	0.2	0.6	4	0.6	1.4	5	0.7	2.0
5	-120 to -106	0	0.0	0.6	0	0.0	1.4	4	0.6	2.6
6	-105 to -91	1	0.2	0.8	3	0.4	1.9	3	0.4	3.0
7	-90 to -76	4	0.6	1.4	4	0.6	2.4	2	0.3	3.3
8	-75 to -61	3	0.5	1.8	4	0.6	3.0	8	1.2	4.5
9	-60 to -46	7	1.1	2.9	7	1.0	4.0	3	0.4	4.9
10	-45 to -31	9	1.4	4.2	12	1.7	5.8	14	2.0	6.9
11	-30 to -16	14	2.1	6.4	10	1.4	7.2	11	1.6	8.5
12	-15 to -1	44	6.7	13.0	32	4.6	11.8	31	4.5	13.0
13	0 to 14	78	11.8	24.8	64	9.2	21.0	38	5.5	18.4
14	15 to 29	156	23.6	48.4	103	14.8	35.9	80	11.5	30.0
15	30 to 44	157	23.8	72.2	142	20.5	56.3	118	17.0	47.0
16	45 to 59	94	14.2	86.4	124	17.9	74.2	107	15.4	62.4
17	60 to 74	40	6.1	92.4	71	10.2	84.4	70	10.1	72.5
18	75 to 89	23	3.5	95.9	51	7.3	91.8	65	9.4	81.8
19	90 to 104	15	2.3	98.2	26	3.7	95.5	39	5.6	87.5
20	105 to 119	6	0.9	99.1	11	1.6	97.1	38	5.5	92.9
21	120 to 134	2	0.3	99.4	13	1.9	99.0	26	3.7	96.7
22	135 to 149	3	0.5	99.8	5	0.7	99.7	12	1.7	98.4
23	150 to 164	1	0.2	100.0	1	0.1	99.9	9	1.3	99.7
24	165 to 180	0	0.0	100.0	1	0.1	100.0	2	0.3	100.0
TOTAL ALL CLASSES:		661			694			694		

Table 108 - 2.4 WIND TURN, 10 DEGREE BACKING ALLOWED, ALBROOK, CANAL ZONE

Class	Wind Turn	SURF TO 500 M #	%	Cum %	SURF TO 1000M #	%	Cum %	SURF TO 1500 M #	%	Cum %
1	-10 to 0	130	17.4	17.4	110	14.7	14.7	98	13.1	13.1
2	1 to 15	123	16.4	33.8	86	11.5	26.2	60	8.0	21.1
3	16 to 30	201	26.8	60.6	133	17.8	43.9	96	12.8	33.9
4	31 to 45	146	19.5	80.1	143	19.1	63.0	123	16.4	50.3
5	46 to 60	70	9.3	89.5	113	15.1	78.1	124	16.6	66.9
6	61 to 75	36	4.8	94.3	62	8.3	86.4	73	9.7	76.6
7	76 to 90	22	2.9	97.2	44	5.9	92.3	51	6.8	83.4
8	91 to 105	9	1.2	98.4	23	3.1	95.3	41	5.5	88.9
9	106 to 120	6	0.8	99.2	12	1.6	96.9	27	3.6	92.5
10	121 to 135	1	0.1	99.3	13	1.7	98.7	30	4.0	96.5
11	136 to 150	3	0.4	99.7	3	0.4	99.1	9	1.2	97.7
12	151 to 165	1	0.1	99.9	1	0.1	99.2	6	0.8	98.5
13	166 to 180	0	0.0	99.9	0	0.0	99.2	1	0.1	98.7
14	181 to 195	0	0.0	99.9	2	0.3	99.5	2	0.3	98.9
15	196 to 210	0	0.0	99.9	1	0.1	99.6	2	0.3	99.2
16	211 to 225	0	0.0	99.9	1	0.1	99.7	1	0.1	99.3
17	226 to 240	0	0.0	99.9	1	0.1	99.9	2	0.3	99.6
18	241 to 255	0	0.0	99.9	0	0.0	99.9	0	0.0	99.6
19	256 to 270	0	0.0	99.9	0	0.0	99.9	1	0.1	99.7
20	271 to 285	0	0.0	99.9	0	0.0	99.9	0	0.0	99.7
21	286 to 300	0	0.0	99.9	0	0.0	99.9	0	0.0	99.7
22	301 to 315	0	0.0	99.9	0	0.0	99.9	0	0.0	99.7
3	316 to 330	1	0.1	100.0	1	0.1	100.0	1	0.1	99.9
4	331 to 345	0	0.0	100.0	0	0.0	100.0	1	0.1	100.0
5	346 to 360	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TAL ALL CLASSES:			749			749			749	

Tab;e 108 - 2.5 WIND TURN, NO BACKING ALLOWED, ALBROOK, CANAL ZONE.

		SURF TO 500 M			SURF TO 1000M			SURF TO 1500 M		
Class	Wind Turn	#	%	Cum %	#	%	Cum %	#	%	Cum %
1	0	133	17.8	17.8	126	16.8	16.8	123	16.4	16.4
2	1 to 15	132	17.6	35.4	83	11.1	27.9	61	8.1	24.6
3	16 to 30	203	27.1	62.5	126	16.8	44.7	97	13.0	37.5
4	31 to 45	140	18.7	81.2	138	18.4	63.2	112	15.0	52.5
5	46 to 60	66	8.8	90.0	108	14.4	77.6	116	15.5	68.0
6	61 to 75	36	4.8	94.8	66	8.8	86.4	74	9.9	77.8
7	76 to 90	20	2.7	97.5	40	5.3	91.7	48	6.4	84.2
8	91 to 105	9	1.2	98.7	24	3.2	94.9	39	5.2	89.5
9	106 to 120	6	0.8	99.5	12	1.6	96.5	32	4.3	93.7
10	121 to 135	1	0.1	99.6	15	2.0	98.5	27	3.6	97.3
11	136 to 150	2	0.3	99.9	4	0.5	99.1	7	0.9	98.3
12	151 to 165	1	0.1	100.0	3	0.4	99.5	5	0.7	98.9
13	166 to 180	0	0.0	100.0	0	0.0	99.5	1	0.1	99.1
14	181 to 195	0	0.0	100.0	2	0.3	99.7	1	0.1	99.2
15	196 to 210	0	0.0	100.0	1	0.1	99.9	2	0.3	99.5
16	211 to 225	0	0.0	100.0	0	0.0	99.9	0	0.0	99.5
7	226 to 240	0	0.0	100.0	1	0.1	100.0	2	0.3	99.7
8	241 to 255	0	0.0	100.0	0	0.0	100.0	0	0.0	99.7
9	256 to 270	0	0.0	100.0	0	0.0	100.0	1	0.1	99.9
0	271 to 285	0	0.0	100.0	0	0.0	100.0	0	0.0	99.9
1	286 to 300	0	0.0	100.0	0	0.0	100.0	0	0.0	99.9
2	301 to 315	0	0.0	100.0	0	0.0	100.0	0	0.0	99.9
3	316 to 330	0	0.0	100.0	0	0.0	100.0	0	0.0	99.9
	331 to 345	0	0.0	100.0	0	0.0	100.0	1	0.1	100.0
	346 to 360	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TAL ALL CLASSES:		749			749			749		

Table 108 - 2.6 , WIND TURN, BERLIN, GERMANY

Wind direction at top height minus wind direction at surface.

Class	Wind Turn	500 M #	500 M %	500 M Cum %	1000 M #	1000 M %	1000 M Cum %	1500 M #	1500 M %	1500 M Cum %
1	-180 to -166	4	0.2	0.2	4	0.2	0.2	7	0.3	0.3
2	-165 to -151	2	0.1	0.3	5	0.2	0.4	11		
3	-150 to -136	0	0.0	0.3	5	0.2	0.6	10	0.4	1.3
4	-135 to -121	2	0.1	0.4	7	0.3	0.9	12	0.5	1.8
5	-120 to -106	6	0.3	0.8	12	0.5	1.5	15	0.7	2.5
6	-105 to -91	9	0.5	1.2	8	0.4	1.8	13	0.6	3.0
7	-90 to -76	6	0.3	1.6	19	0.9	2.7	23	1.0	4.1
8	-75 to -61	12	0.8	2.3	24	1.1	3.8	36	1.6	5.7
9	-60 to -46	32	1.7	4.1	40	1.8	5.6	50	2.2	7.9
10	-45 to -31	57	3.1	7.1	66	3.0	8.5	63	2.8	10.7
11	-30 to -16	155	8.4	15.5	132	5.9	14.5	118	5.3	16.0
12	-15 to -1	245	13.3	28.8	256	11.5	26.0	216	9.7	25.7
13	0 to 14	363	19.6	48.4	386	17.4	43.4	290	13.0	38.6
14	15 to 29	408	22.1	70.5	443	19.9	63.3	375	16.8	55.4
15	30 to 44	270	14.6	85.1	355	16.0	79.3	384	17.2	72.6
16	45 to 59	146	7.9	03.0	230	10.3	89.6	241	10.8	83.4
17	60 to 74	63	3.4	96.4	98	4.4	94.0	143	6.4	89.8
18	75 to 89	31	1.7	98.1	54	2.4	96.4	80	3.6	93.3
19	90 to 104	12	0.6	98.8	39	1.8	99.2	49	2.2	95.5
20	105 to 119	7	0.4	99.1	16	0.7	98.9	36	0.6	97.1
21	120 to 134	5	0.3	99.4	11	0.5	99.4	22	1.0	98.1
22	135 to 149	2	0.1	99.5	5	0.2	99.6	12	0.8	98.9
23	150 to 164	6	0.3	99.8	3	0.1	99.8	15	0.7	99.6
24	165 to 180	1	0.2	100.0	5	0.2	100.0	10	0.4	100.0
TOTAL ALL CLASSES:		1848			2223			2236		

Table 108 2.7 WIND TURN, 10 DEGREE BACKING ALLOWED , BERLIN, GERMANY

		SURF TO 500 M			SURF TO 1000M			SURF TO 1500 M		
Class	Wind Turn	#	%	Cum %	#	%	Cum %	#	%	Cum %
1	-10 to 0	2346	44.8	44.8	1881	35.9	35.9	1760	33.6	33.6
2	1 to 15	1030	19.7	64.5	905	17.3	53.2	733	14.0	47.6
3	16 to 30	832	15.9	80.4	929	17.7	71.0	826	15.8	63.4
4	31 to 45	515	9.8	90.2	659	12.6	83.6	743	14.2	77.6
5	46 to 60	258	4.9	95.2	419	8.0	91.6	490	9.4	87.0
6	61 to 75	128	2.4	97.6	187	3.6	95.1	281	5.4	92.3
7	76 to 90	47	0.9	98.5	97	1.9	97.0	140	2.7	95.0
8	91 to 105	30	0.6	99.1	57	1.1	98.1	92	1.8	96.8
9	106 to 120	15	0.3	99.4	38	0.7	98.8	57	1.1	97.9
10	121 to 135	10	0.2	99.6	24	0.5	99.3	35	0.7	98.5
11	136 to 150	8	0.2	99.7	11	0.2	99.5	26	0.5	99.0
12	151 to 165	6	0.1	99.8	10	0.2	99.7	13	0.2	99.3
13	166 to 180	3	0.1	99.9	6	0.1	99.8	14	0.3	99.5
14	181 to 195	2	0.0	99.9	3	0.1	99.8	10	0.2	99.7
15	196 to 210	1	0.0	99.9	2	0.0	99.9	3	0.1	99.8
.6	211 to 225	1	0.0	100.0	1	0.0	99.9	3	0.1	99.8
7	226 to 240	0	0.0	100.0	2	0.0	99.9	2	0.0	99.9
8	241 to 255	0	0.0	100.0	0	0.0	99.9	2	0.0	99.9
9	256 to 270	1	0.0	100.0	0	0.0	99.9	0	0.0	99.9
0	271 to 285	0	0.0	100.0	1	0.0	100.0	1	0.0	99.9
1	286 to 300	0	0.0	100.0	1	0.0	100.0	2	0.0	100.0
2	301 to 315	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
3	316 to 330	1	0.0	100.0	0	0.0	100.0	0	0.0	100.0
	331 to 345	0	0.0	100.0	1	0.0	100.0	1	0.0	100.0
	346 to 360	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TAL ALL CLASSES:			5234			5234			5234	

Table 108 - 2.8 WIND TURN, NO BACKING ALLOWED , BERLIN, GERMANY

Class	Wind Turn	SURF TO 500 M #	%	Cum %	SURF TO 1000M #	%	Cum %	SURF TO 1500 M #	%	Cum %
1	-10 to 0	2431	46.4	46.4	2168	41.4	41.4	2127	40.6	40.6
2	1 to 15	989	18.9	65.3	733	14.0	55.4	586	11.2	51.8
3	16 to 30	807	15.4	80.8	877	16.8	72.2	770	14.7	66.5
4	31 to 45	513	9.8	90.6	635	12.1	84.3	690	13.2	79.7
5	46 to 60	246	4.7	95.3	392	7.5	91.8	439	8.4	88.1
6	61 to 75	128	2.4	97.7	193	3.7	95.5	260	5.0	93.1
7	76 to 90	47	0.9	98.6	88	1.7	97.2	133	2.5	95.6
8	91 to 105	27	0.5	99.1	53	1.0	98.2	75	1.4	97.1
9	106 to 120	14	0.3	99.4	35	0.7	98.9	51	1.0	98.0
10	121 to 135	8	0.2	99.5	23	0.4	99.3	31	0.6	98.6
11	136 to 150	9	0.2	99.7	12	0.2	99.5	24	0.5	99.1
12	151 to 165	6	0.1	99.8	8	0.2	99.7	12	0.2	99.3
13	166 to 180	3	0.1	99.9	6	0.1	99.8	14	0.3	99.6
14	181 to 195	2	0.0	99.9	3	0.1	99.8	9	0.2	99.8
15	196 to 210	1	0.0	99.9	2	0.0	99.9	3	0.1	99.8
6	211 to 225	1	0.0	100.0	1	0.0	99.9	2	0.0	99.8
7	226 to 240	0	0.0	100.0	2	0.0	99.9	2	0.0	99.9
8	241 to 255	0	0.0	100.0	0	0.0	99.9	2	0.0	99.9
9	256 to 270	1	0.0	100.0	0	0.0	99.9	0	0.0	99.9
0	271 to 285	0	0.0	100.0	1	0.0	100.0	1	0.0	99.9
1	286 to 300	0	0.0	100.0	1	0.0	100.0	2	0.0	100.0
2	301 to 315	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
3	316 to 330	1	0.0	100.0	0	0.0	100.0	0	0.0	100.0
	331 to 345	0	0.0	100.0	1	0.0	100.0	1	0.0	100.0
	346 to 360	0	0.0	100.0	0	0.0	100.0	0	0.0	100.0
TAL ALL CLASSES:		5234			5234			5234		

Table 108 -2.9 WIND TURN THULE, GREENLAND

Wind direction at top height minus wind direction at surface.

Class	Wind Turn	SURF TO 500 M #	%	Cum %	SURF TO 1000 M #	%	Cum %	SURF TO 1500 M #	%	Cum %
1	-180 to -166	240	2.3	2.3	249	2.3	2.3	287	2.7	2.7
2	-165 to -151	267	2.5	4.8	297	2.8	5.1	323	3.1	5.8
3	-150 to -136	326	3.1	7.9	339	3.2	8.3	394	3.8	9.6
4	-135 to -121	332	3.2	11.1	408	3.8	12.2	407	3.9	13.5
5	-120 to -106	381	3.6	14.7	437	4.1	16.3	428	4.1	17.6
6	-105 to -91	393	3.7	18.4	448	4.2	20.5	421	4.0	21.6
7	-90 to -76	448	4.3	22.7	424	4.0	24.5	406	3.9	25.5
8	-75 to -61	469	4.5	27.1	408	3.8	28.4	394	3.8	29.3
9	-60 to -46	565	5.4	32.5	477	4.5	32.9	390	3.7	33.0
10	-45 to -31	621	5.9	38.4	495	4.7	37.5	376	3.6	36.6
11	-30 to -16	655	6.2	44.6	540	5.1	42.6	432	4.1	40.7
12	-15 to -1	740	7.0	51.6	595	5.6	48.2	535	5.1	45.8
13	0 to 14	896	8.5	60.1	810	7.6	55.8	670	6.4	52.3
14	15 to 29	678	6.4	66.5	819	7.7	63.6	727	7.0	59.2
15	30 to 44	671	6.4	72.9	726	6.8	70.4	719	6.9	66.1
16	45 to 59	565	5.4	78.3	628	5.9	76.3	684	6.5	72.6
17	60 to 74	442	4.2	82.5	575	5.4	81.7	612	5.9	78.5
18	75 to 89	335	3.2	85.6	375	3.5	85.3	431	4.1	82.6
19	90 to 104	305	2.9	88.5	312	2.9	88.2	378	3.6	86.2
20	105 to 119	226	2.1	90.7	216	2.0	90.2	315	3.0	89.2
21	120 to 134	231	2.2	92.9	255	2.4	92.6	293	2.8	92.0
22	135 to 149	218	2.1	95.0	241	2.3	94.9	273	2.6	94.6
23	150 to 164	239	2.3	97.2	246	2.3	97.2	252	2.4	97.1
24	165 to 180	293	2.8	100.0	294	2.8	100.0	308	2.9	100.0
OTAL ALL CLASSES:		10536			10614			10455		

Table 108 - 2.10 WIND TURN , 0 DEGREE BACKING ALLOWED, THULE, GREENLAND.

Class	Wind Turn	SURF TO 500 M #	%	Cum %	SURF TO 1000M #	%	Cum %	SURF TO 1500 M #	%	Cum %
1	-10 to 0	5516	51.9	51.9	5317	50.0	50.0	5265	49.5	49.5
2	1 to 15	881	8.3	60.1	774	7.3	57.3	597	5.6	55.1
3	16 to 30	749	7.0	67.2	685	6.4	63.7	630	5.9	61.0
4	31 to 45	631	5.9	73.1	566	5.3	69.0	515	4.8	65.9
5	46 to 60	518	4.9	78.0	539	5.1	74.1	551	5.2	71.0
6	61 to 75	386	3.6	81.6	422	4.0	78.1	416	3.9	75.0
7	76 to 90	292	2.7	84.3	346	3.3	81.3	352	3.3	78.3
8	91 to 105	254	2.4	86.7	254	2.4	83.7	281	2.6	80.9
9	106 to 120	243	2.3	89.0	242	2.3	86.0	277	2.6	83.5
10	121 to 135	187	1.8	90.8	211	2.0	87.9	223	2.1	85.6
11	136 to 150	214	2.0	92.8	232	2.2	90.1	230	2.2	87.8
12	151 to 165	197	1.9	94.6	217	2.0	92.2	230	2.2	89.9
13	166 to 180	181	1.7	96.3	182	1.7	93.9	195	1.8	91.8
14	181 to 195	113	1.1	97.4	134	1.3	95.1	176	1.7	93.4
15	196 to 210	90	0.8	98.3	111	1.0	96.2	124	1.2	94.6
6	211 to 225	71	0.7	98.9	104	1.0	97.2	139	1.3	95.9
7	226 to 240	47	0.4	99.4	95	0.9	98.1	101	0.9	96.8
8	241 to 255	28	0.3	99.6	60	0.6	98.6	75	0.7	97.5
9	256 to 270	17	0.2	99.8	44	0.4	99.0	55	0.5	98.1
)	271 to 285	10	0.1	99.9	22	0.2	99.2	37	0.3	98.4
1	286 to 300	3	0.0	99.9	23	0.2	99.5	30	0.3	98.7
2	301 to 315	2	0.0	99.9	10	0.1	99.5	29	0.3	99.0
3	316 to 330	4	0.0	100.0	12	0.1	99.7	24	0.2	99.2
	331 to 345	3	0.0	100.0	13	0.1	99.8	14	0.1	99.3
	346 to 360	1	0.0	100.0	23	0.2	100.0	72	0.7	100.0
TAL ALL CLASSES:		10638			10638			10638		

Table 108 - 2.11 WIND TURN, NO BACKING ALLOWE, THULE, GREENLAND

		SURF TO 500 M			SURF TO 1000M			SURF TO 1500 M		
Class	Wind Turn	#	%	Cum %	#	%	Cum %	#	%	Cum %
1	0	5775	54.3	54.3	5717	53.7	53.7	5704	53.6	53.6
2	1 to 15	794	7.5	61.8	643	6.0	59.8	559	5.3	58.9
3	16 to 30	701	6.6	68.3	603	5.7	65.5	534	5.0	63.9
4	31 to 45	596	5.6	73.9	526	4.9	70.4	482	4.5	68.4
5	46 to 60	507	4.8	78.7	489	4.6	75.0	488	4.6	73.0
6	61 to 75	365	3.4	82.1	388	3.6	78.6	384	3.6	76.6
7	76 to 90	286	2.7	84.8	327	3.1	81.7	335	3.1	79.8
8	91 to 105	243	2.3	87.1	256	2.4	84.1	255	2.4	82.2
9	106 to 120	230	2.2	89.3	236	2.2	86.3	251	2.4	84.5
10	121 to 135	180	1.7	91.0	197	1.9	88.2	213	2.0	86.5
11	136 to 150	208	2.0	92.9	212	2.0	90.2	208	2.0	88.5
12	151 to 165	189	1.8	94.7	212	2.0	92.2	222	2.1	90.6
13	166 to 180	182	1.7	96.4	175	1.6	93.8	178	1.7	92.2
14	181 to 195	111	1.0	97.5	128	1.2	95.0	163	1.5	93.8
15	196 to 210	88	0.8	98.3	105	1.0	96.0	113	1.1	94.8
16	211 to 225	69	0.6	98.9	107	1.0	97.0	128	1.2	96.0
.7	226 to 240	48	0.5	99.4	91	0.9	97.9	104	1.0	97.0
.8	241 to 255	27	0.3	99.6	65	0.6	98.5	73	0.7	97.7
9	256 to 270	17	0.2	99.8	41	0.4	98.9	51	0.5	98.2
0	271 to 285	9	0.1	99.9	28	0.3	99.1	35	0.3	98.5
1	286 to 300	3	0.0	99.9	25	0.2	99.4	26	0.2	98.8
2	301 to 315	2	0.0	99.9	14	0.1	99.5	27	0.3	99.0
3	316 to 330	4	0.0	100.0	13	0.1	99.6	25	0.2	99.2
	331 to 345	3	0.0	100.0	12	0.1	99.7	13	0.1	99.4
	346 to 360	1	0.0	100.0	28	0.3	100.0	67	0.6	100.0
TAL ALL CLASSES:		10638			10638			10638		

Letter Report 108 - 3 15 May 1998.

This letter report provides wind directional profiles for 4 significant climate regimes associated with the 50 - 99 % exceedance wind speed profiles described in FARMY - 43 Report. This letter report includes summer conditions (June - August) of the mean wind direction for 4 stations.

In order to associate the directional profiles with the respective wind speed profiles the boundaries of the wind speed profile for the applicable exceedance level of the wind speed profile was determined for every altitude from surface to 25 km. For each of these intervals from surface to 25 kn the directional profile data were selected, summarized at each altitude level, and the mean direction as outlined by Essenwanger (1986) was computed. This was done for every exceedance level of the wind speed peofile. The result is given in Tables 108 -3.1 to 3.4.

At Albrook (Table 108 -3.1) we find q shift of about 90 degrees of the wind direction above 18 km towards Southeast from the mean direction for the 50% exceedance level 10 - 14 km.. to the 99 % exceedance level.Thus the strong wind speeds are appaewnrlt coming from a slightly different circulation system in that region.

This shift is not found for Montgomery (Table 108 - 3.2) or Berlin (Table 108 - 3.3).

At Thule (Table 108 - 3.4) the mean wind directions shift from Northwesterlies above 18 km towarss westerlies for strong Wind speeds. This is opposite what we find at Albrooks.

These results indicate that calculatuins of the MET error for Army missile system should take wind direction shifts above 18 km for strong winds into account.

Table 108 - 3.5 is depicting the mean sind directional profiles for the summer months (June - August) for 4 stations where wind speed profiles have been established (FARMY - 43). We learn that in summer above about 18 km the wind shifts in summer towards Easterlies. This is expected from the atmospheric general circulation system of the atmosphere.

Table 108 - 3.1 Wind Direction Profiles Associated with Respective Wind Speed Profiles.

Albrook, Canal Zone

km	50%	68%	84%	90%	95%	99%
0	326	323	333	326	333	336
1	29	30	17	355	11	11
2	20	5	41	20	39	34
3	6	333	74	89	63	83
4	126	133	104	114	102	105
5	75	59	106	98	100	104
6	191	231	91	80	89	77
7	210	255	122	104	333	315
8	214	256	330	152	295	288
9	211	240	212	235	250	243
10	210	236	207	237	231	239
11	206	224	205	215	233	237
12	207	225	209	227	236	250
13	206	216	223	246	241	248
14	239	245	237	244	251	259
15	240	250	254	256	271	264
16	221	243	210	219	295	303
17	13	352	89	64	27	184
18	13	356	74	39	63	131
19	348	315	28	29	19	138
20	343	314	14	20	13	7
21	347	315	13	13	5	16
22	351	316	15	13	18	17
23	199	236	28	41	16	8
24	195	236	28	46	17	9
25	340	237	28	47	21	14

Table 108 - 3.2 Wind Direction Profiles Associated with Respective Wind Soeed Profile.

Montgomery, Alabama

km	50%	68%	84%	90%	95%	99%
0	133	315	300	299	332	332
1	237	267	284	275	288	291
2	258	271	277	274	281	278
3	260	272	272	270	273	271
4	262	271	271	268	270	268
5	w65	w79	269	266	257	264
6	267	269	269	264	264	261
7	267	269	269	263	263	259
8	266	268	266	262	262	258
9	267	267	265	262	261	257
10	267	266	265	261	262	265
11	267	266	264	261	261	258
12	267	267	265	262	262	259
13	267	267	265	262	262	259
14	267	268	265	262	262	258
15	267	268	265	262	262	250
16	268	269	265	263	263	260
17	268	269	266	265	264	261
18	269	271	266	266	265	262
19	273	281	269	269	266	262
20	315	301	273	271	270	250
21	351	314	272	272	272	257
22	359	316	281	282	271	261
23	165	347	299	290	275	268
24	163	349	318	200	272	268
25	5	345	313	297	269	269

Table 108 = 3.3 Wind Direction Profiles Associated with Respective Wind Profile

Berlin, Germany

km	50%	68%	84%	90%	95%	99%
0	242	255	260	265	270	272
1	268	273	277	282	281	284
2	281	283	287	297	297	305
3	282	284	289	301	299	307
4	281	285	290	303	300	307
5	283	285	291	305	302	308
6	284	286	292	307	304	309
7	284	286	292	308	304	309
8	284	286	293	309	303	307
9	285	287	293	310	303	305
10	284	286	294	312	304	307
11	285	287	293	315	303	306
12	285	287	292	313	304	307
13	284	287	291	311	304	307
14	283	287	191	309	303	305
15	281	286	290	309	299	301
16	280	285	189	307	297	298
17	279	283	287	304	295	297
18	276	279	286	302	293	294
19	273	277	285	301	290	291
20	269	274	285	301	290	292
21	255	270	282	298	289	291
22	242	266	279	296	286	288
23	238	258	279	299	292	290
24	335	254	275	297	289	286
25	334	244	272	296	287	283

Table 108 - 3.4 Wind Direction Profiles Associated with Respective Wind Soeed Profile.

Thule, Greenland

km	50%	68%	84%	90%	95%	99%
0	121	121	123	124	132	105
1	88	117	123	121	117	93
2	89	149	197	192	183	262
3	238	224	225	212	211	251
4	239	228	229	213	214	250
5	239	235	230	235	218	248
6	236	229	231	226	220	251
7	237	237	231	229	225	251
8	239	236	234	230	227	251
9	239	237	234	230	227	254
10	241	238	234	231	228	254
11	242	239	232	229	227	253
12	254	240	234	229	227	251
13	255	242	238	236	229	252
14	259	250	241	236	232	253
15	267	254	243	243	238	257
16	268	254	241	243	234	257
17	272	254	242	242	240	235
18	285	266	256	257	253	262
19	300	269	257	239	258	256
20	303	288	286	283	294	266
21	302	224	223	224	270	267
22	315	221	223	212	272	270
23	329	209	213	209	241	269
24	344	346	224	208	329	272
25	344	348	227	208	344	335

Table 108 3.5 Wind Direction Profiles for Summer.
Four Stations During June - August.

km	Alb	Mtg	Ber	Thu
0	314	184	306	247
1	58	259	302	107
2	80	271	303	121
3	95	287	304	227
4	105	298	303	225
5	112	304	302	235
6	107	306	300	227
7	111	305	298	228
8	112	302	295	236
9	102	297	289	238
10	107	297	288	237
11	93	298	289	239
12	89	301	292	254
13	82	307	290	260
14	77	312	290	265
15	87	329	285	316
16	92	349	281	102
17	87	26	280	100
18	79	67	273	82
19	93	81	182	83
20	87	84	130	88
21	81	86	110	97
22	84	86	106	94
23	81	87	106	95
24	85	87	101	95
25	84	88	103	95

Letter Report 108 - 4 16 May 1998.

This letter report gives information about the exceedance probability for thresholds running from 50 to 99 % of the wind speed profile in the Middle East.

The raw data were furnished on magnetic tape by the Technical Application Center of the Air Force at Asheville, N.C. They were converted to PC disks for use in the development of the wind speed profiles for Middle East stations.

a) Dhahran, Saudi Arabia (Table 108 - 4.1)
b) Abu Dhabi, United Emerates (Table 108 - 4.2)
c) Rhyadh, Saudi Arabia. (Table 108 - 4.3)
dc) Bet Dagan, Israe (Yable 108 - 4.4)

The data were in block form of lines with 255 digits. The station number, time information, and upper air data were separated by a character ^Z. Thus the first program needed to separate the information into accessable individual lines.

While the station nummber was recognizable, the time information with 18 characters was supposed to have 18 digits with the last digits providing information how many lines of 32 characters were in the upper air data. Unfortunately this line of 18 digits contained anything from 2 to 18 digits. Thus the length of the uppwer air data could not be determined by the number in the time information. A cutoff was made by the station number.

Although the lines of upper air information were supposed to have 32 characters, the number of the digits in the last line from the converted 255 charcters contained less depending on how many ^Z characters were in the line, and the numwerical remainder in the 255 total. However, the line was supplemented in the next 255 line. Thus separate programs had to be established to standardise the upper air information. The supplementation of the last 32 character line was necessary because the last 7 digits of the line contauined the information about wind speed and direction.

After the standardization programs the upper air data were normalized at metric altitude intervals of 1 km from surface to 25 km.

TYhe next step was a Fourier analysis of the wind speed profile, with calculation of the frequency distributions of the coefficients. Then an analytical profile was established for exceedance thresholds 50 to 99 %. E.g. the 99 % profile is exceeded in 1 % of the cases. The technical details are found in FARMY-138 Report.

The wind speed profiles for the exceedance thresholds are provided in Tables 108 - 4.1 to 4,4. We learn that Dhahran, Abu Dhabi, and Rhyad (Tables 108 - 4.1 to 4,3) appear to be in a similar wind speed regime. Howecer, the wind speed profiles at Bet Dagan, Israel, disclose a stronger upper air wind system,, especially between 10 - 14 km..

In addition to these wind speed profiles the meean wind direction for the total year, the winter and summer months, is listed. The tab;es is display that in the summer months the wind shifts to an easterly direction above 8 km.This is in line with expectations from the general circulation of the atmosphere.
More details can be found in the individual tabulations which have been furnished to the MLRS Project Office on computer PC disks upon their request.

Table 108 - 4.1 Eind Speed Profiles for Probabo;oty Level of Exceedance , and Directional Profiles for the Year, Winter, and Summer fpr Dhahran, Saudi Arabia.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	5.3	6.2	6.8	8.8	9.9	11.3	14.6	17.7	8	359	348
1	6.0	7.0	7.7	10.0	11.2	12.8	16.5	20.0	315	340	290
2	7.0	8.3	9.1	11.8	13.3	15.1	19.5	23.6	303	332	284
3	8.3	9.8	10.7	13.9	15.6	17.8	23.0	27.9	304	332	287
4	9.6	11.3	12.4	16.0	18.0	20.5	26.5	32.1	302	345	283
5	10.8	12.7	14.0	18.0	20.3	23.1	29.8	36.2	298	360	282
6	12.1	14.2	15.6	20.2	22.7	25.9	33.4	40.5	299	12	281
7	13.6	16.0	17.6	22.7	25.6	29.1	37.6	45.6	297	349	280
8	15.5	18.2	20.0	25.8	29.1	33.1	42.8	51.9	297	356	280
9	17.8	20.9	23.0	29.7	33.5	38.1	49.2	59.6	297	358	280
10	20.0	23.5	25.9	33.4	37.6	42.8	55.2	67.0	285	180	279
11	21.9	25.8	28.4	36.6	41.2	46.9	60.6	73.5	268	179	279
12	23.2	27.3	30.0	38.8	43.7	49.7	64.1	77.8	254	169	279
13	23.2	27.2	30.0	38.7	43.6	49.6	64.0	77.7	241	165	277
14	21.7	25.5	28.1	36.2	40.8	46.4	60.0	72.7	236	159	276
15	19.5	23.0	25.3	32.6	36.7	41.8	53.9	65.4	226	150	275
16	17.1	20.1	22.1	28.5	32.1	36.6	47.2	57.2	222	147	275
17	14.3	16.8	18.5	23.8	26.9	30.5	39.4	47.8	212	140	270
18	12.2	14.4	15.8	20.4	23.0	26.2	33.8	41.0	206	130	279
19	11.7	13.8	15.1	19.5	22.0	25.1	32.4	39.2	206	118	276
20	11.7	13.7	15.1	19.5	22.0	25.0	32.3	39.2	175	108	281
21	11.6	13.6	15.0	19.3	21.8	24.8	32.0	38.8	154	110	235
22	10.8	12.7	14.0	18.1	20.4	23.2	29.9	36.3	168	116	270
23	9.3	11.0	12.1	15.6	17.5	19.9	25.8	31.2	150	106	315
24	7.3	8.6	9.4	12.2	13.7	15.6	20.1	24.4	61	91	347
25	5.3	6.2	6.8	8.8	10.0	11.3	14.6	17.7	43	102	10

TOTAL = ALL YEAR
SUMMER = MAY - AUG
WINTER = NOV - FEB

Table 108- 4.2 Wind Speed Profiles for Probability Level of Exceedance, and Directionel Profiles for the Year, Winter, and Summer for Abu Dhabi , Emerates.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	4.2	4.9	5.4	7.0	7.9	8.9	11.6	14.0	360	349	1
1	4.8	5.7	6.3	8.1	9.1	10.4	13.4	16.2	298	303	287
2	6.1	7.2	7.9	10.2	11.5	13.0	16.8	20.4	282	300	267
3	7.8	9.2	10.1	13.0	14.7	16.7	21.5	26.1	286	348	271
4	9.8	11.5	12.7	16.4	18.5	21.0	27.1	32.9	301	16	271
5	12.0	14.1	15.5	20.0	22.6	25.7	33.2	40.2	301	28	269
6	14.3	16.8	18.5	23.8	26.9	30.6	39.5	47.8	301	19	269
7	16.6	19.5	21.4	27.7	31.2	35.5	45.8	55.5	302	18	269
8	18.8	22.1	24.3	31.4	35.4	40.2	52.0	63.0	299	14	269
9	20.8	24.5	27.0	34.8	39.2	44.6	57.6	69.9	298	14	270
10	22.4	26.3	28.9	37.4	42.1	47.9	61.8	75.0	288	27	270
11	23.4	27.5	30.3	39.1	44.0	50.1	64.6	78.4	253	29	269
12	23.8	28.0	30.8	39.7	44.7	50.9	65.7	79.7	238	153	270
13	24.0	28.2	31.0	40.1	45.1	51.3	66.3	80.4	230	152	269
14	22.1	26.1	28.7	37.0	41.7	47.4	61.2	74.3	228	155	268
15	19.6	23.1	25.4	32.8	36.9	42.0	54.2	65.7	225	153	269
16	16.7	19.7	21.7	28.0	31.5	35.8	46.3	56.1	221	139	269
17	14.2	16.7	18.3	23.6	26.6	30.3	39.1	47.5	223	160	270
18	10.6	12.4	13.7	17.6	19.9	22.6	29.2	35.4	211	134	269
19	7.9	9.3	10.2	13.2	14.8	16.9	21.8	26.4	213	159	263
20	6.8	8.0	8.8	11.3	12.8	14.5	18.7	22.7	198	124	280
21	7.1	8.3	9.2	11.8	13.3	15.2	19.6	23.8	230	160	265
22	8.1	9.5	10.5	13.5	15.3	17.4	22.4	27.2	195	140	266
23	8.9	10.5	11.5	14.9	16.8	19.1	24.6	29.8	197	61	271
24	8.7	10.3	11.3	14.6	16.5	18.7	24.2	29.3	320	9	276
25	7.4	8.7	9.6	12.4	14.0	15.9	20.5	24.9	288	225	274

TOTAL = ALL YEAR
SUMMER = JUN - AUG
WINTER = NOV - MAR

Table 108 -4.3 Wind Speed Profiles for Probability Levels of Exceedance, and Directional Profiles for Year, Winter, and Summer for Rhyad, Suudi Arabia.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	3.8	4.4	4.9	6.3	7.1	8.1	10.4	12.7	12	10	13
1	4.9	5.8	6.4	8.3	9.3	10.6	13.7	16.6	43	41	275
2	6.6	7.8	8.6	11.1	12.5	14.2	18.4	22.3	303	330	268
3	8.4	9.9	10.9	14.1	15.9	18.1	23.3	28.3	302	310	272
4	10.0	11.8	12.9	16.7	18.8	21.4	27.7	33.5	304	313	272
5	11.2	13.2	14.5	18.7	21.1	24.0	31.0	37.6	301	314	277
6	12.2	14.3	15.8	20.4	22.9	26.1	33.7	40.9	302	318	274
7	13.3	15.6	17.2	22.2	25.0	28.4	36.7	44.5	299	327	275
8	14.8	17.4	19.1	24.7	27.8	31.6	40.8	49.5	285	331	272
9	17.3	20.3	22.4	28.9	32.5	37.0	47.8	57.9	286	193	277
10	19.3	22.8	25.0	32.3	36.4	41.4	53.5	64.8	257	193	277
11	21.1	24.9	27.4	35.3	39.8	45.3	58.4	70.9	253	199	279
12	22.3	26.2	28.8	37.2	42.0	47.7	61.6	74.7	238	193	279
13	22.9	27.0	29.7	38.3	43.1	49.1	63.4	76.8	236	191	279
14	23.3	27.1	29.6	37.6	42.1	47.6	60.9	73.4	225	183	277
15	20.9	24.2	26.4	33.5	37.5	42.4	54.2	65.3	226	185	272
16	18.2	21.0	22.9	29.0	32.4	36.6	46.7	56.2	216	174	276
17	15.6	18.0	19.6	24.8	27.6	31.2	39.7	47.7	210	166	271
18	12.6	14.4	15.7	19.6	21.9	24.6	31.2	37.4	202	153	274
19	10.6	12.1	13.2	16.4	18.2	20.5	25.8	30.9	180	133	273
20	10.0	11.4	12.3	15.3	17.0	19.1	24.0	28.7	164	121	271
21	10.2	11.7	12.7	15.8	17.5	19.6	24.8	29.6	147	104	276
22	10.7	12.3	13.3	16.6	18.5	20.7	26.2	31.3	148	104	275
23	10.8	12.4	13.4	16.7	18.6	20.8	26.3	31.5	133	102	298
24	10.0	11.4	12.4	15.4	17.1	19.1	24.1	28.9	134	94	286
25	8.5	9.6	10.4	12.8	14.2	15.8	19.9	23.7	135	105	298

TOTAL = ALL YEAR
SUMMER = MAY - AUG
WINTER = NOV - FEB

Table 108- 4.4 Wind Speed Profiles for Probability Level og Exceedance, and Wind Direction Profiles for Year, Winter, and Summer for Bet Dagan, Israel.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	4.2	5.0	5.5	7.0	7.9	9.0	11.7	14.1	317	317	297
1	5.2	6.1	6.7	8.7	9.8	11.1	14.4	17.4	285	302	241
2	6.9	8.1	8.9	11.5	12.9	14.7	19.0	23.0	268	287	252
3	8.9	10.5	11.5	14.9	16.7	19.0	24.6	29.8	265	268	260
4	11.0	12.9	14.2	18.3	20.6	23.5	30.3	36.8	266	265	268
5	12.9	15.2	16.7	21.6	24.3	27.7	35.7	43.3	266	263	270
6	14.8	17.4	19.1	24.7	27.9	31.7	40.9	49.6	265	260	271
7	16.7	19.7	21.6	27.9	31.5	35.8	46.2	56.1	264	257	272
8	18.9	22.2	24.4	31.5	35.5	40.4	52.2	63.3	264	257	272
9	21.8	25.6	28.2	36.4	41.0	46.7	60.3	73.1	263	253	273
10	23.9	28.1	31.0	40.0	45.0	51.2	66.1	80.2	262	252	272
11	25.7	30.3	33.3	43.0	48.4	55.1	71.1	86.2	262	249	272
12	27.0	31.7	34.9	45.1	50.8	57.7	74.6	90.4	259	242	271
13	28.1	33.0	36.3	46.9	52.9	60.1	77.6	94.2	258	240	271
14	26.8	31.5	34.7	44.8	50.5	57.4	74.1	89.9	255	235	271
15	24.7	29.1	32.0	41.3	46.5	52.9	68.3	82.8	253	231	270
16	22.0	25.9	28.5	36.8	41.5	47.2	60.9	73.9	250	225	270
17	18.7	22.1	24.3	31.3	35.3	40.1	51.8	62.8	244	213	268
18	15.7	18.4	20.3	26.2	29.5	33.5	43.3	52.5	229	182	268
19	13.9	16.3	18.0	23.2	26.2	29.7	38.4	46.6	221	163	267
20	12.8	15.0	16.6	21.4	24.1	27.4	35.4	42.9	198	130	268
21	11.9	14.1	15.5	20.0	22.5	25.6	33.0	40.1	194	118	266
22	10.9	12.9	14.1	18.2	20.6	23.4	30.2	36.6	185	113	267
23	9.5	11.1	12.3	15.8	17.8	20.3	26.2	31.8	170	108	255
24	7.7	9.0	9.9	12.8	14.4	16.4	21.2	25.7	168	104	227
25	5.8	6.9	7.6	9.8	11.0	12.5	16.2	19.6	170	104	255

TOTAL = ALL YEAR
SUMMER = MAY - AUG
WINTER = NOV - FEB

Letter Report 109 - 5 15 May 1998

This letter repprt provides the wind speed profiles for 3 stations in the Scandinavian area.

The technical details of this study to develop wind speed profiles are similar to letter report 108 - 4 but wind speed profiles for this report are from Skandinavian station.

a) Oslo/Gardemoen, Norway (Table 108 - 5.1)
b) Copenhavn/(Kuebenhavn/Jaegersh), Denmark (Table 108 - 5.2)
C) Jan Mayen, Norway, (Table 108 - 5.3)

The tables illustrate that the highest wind speed of the progfiles occur between 6 to 12 km altitude. That is lower than in the subtropical or tropical regions. They are not higher than the previous Middle East stations but much lower than Bet Dagan, Israel or Montgomery.

The mean wind direction stays in the westerly range except for a shift above 20 km in summer for Kopenhaven and Oslo. No shift to easterlies can be found for Jan Mayen.

Table 108 - 5.1 Wind Speed Profiles for Probability Levels of Exceedance, amd Wimd Direction Profiles for Year, Winter, and Summer for Oslo/Gardermoen, Norway.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	4.2	5.3	6.0	8.3	9.6	11.3	15.1	18.7	60	71	54
1	5.2	6.5	7.3	10.0	11.6	13.4	17.9	22.2	286	284	287
2	6.4	7.8	8.8	12.0	13.7	15.9	21.1	26.0	282	273	281
3	7.7	9.4	10.6	14.2	16.3	18.8	24.8	30.5	282	272	282
4	9.2	11.2	12.5	16.8	19.1	22.0	29.0	35.6	282	273	284
5	10.8	13.1	14.6	19.4	22.2	25.5	33.5	41.0	281	273	282
6	12.3	14.8	16.4	21.8	24.8	28.5	37.4	45.8	280	274	280
7	13.2	15.9	17.6	23.4	26.6	30.5	40.0	48.9	281	274	281
8	13.3	16.0	17.8	23.6	26.8	30.8	40.4	49.4	282	273	284
9	15.8	18.1	19.6	24.4	27.1	30.4	38.4	45.9	284	280	286
10	15.0	17.1	18.6	23.1	25.6	28.7	36.2	43.3	284	281	285
11	14.6	16.6	18.0	22.3	24.8	27.7	35.0	41.7	284	273	286
12	14.3	16.3	17.7	22.0	24.4	27.3	34.4	41.0	284	279	287
13	13.8	15.7	16.9	21.0	23.3	26.1	32.8	39.1	284	275	288
14	12.0	13.5	14.6	18.0	19.9	22.2	27.8	33.0	285	275	288
15	10.4	11.7	12.6	15.4	17.0	18.9	23.5	27.9	286	274	291
16	9.4	10.6	11.3	13.8	15.1	16.8	20.8	24.6	286	272	291
17	9.5	10.7	11.6	14.2	15.7	17.5	21.8	26.0	287	271	290
18	9.0	10.2	11.1	13.7	15.2	17.0	21.4	25.5	289	267	292
19	8.7	9.8	10.6	13.1	14.5	16.2	20.4	24.3	288	268	289
20	8.9	10.2	11.0	13.6	15.1	16.9	21.2	25.3	297	228	289
21	9.8	11.2	12.1	15.0	16.7	18.7	23.6	28.2	300	148	291
22	10.8	12.4	13.4	16.7	18.6	20.9	26.4	31.5	314	134	289
23	11.4	13.0	14.1	17.6	19.6	22.0	27.9	33.4	328	76	287
24	11.0	12.6	13.6	17.0	18.9	21.3	26.9	32.2	331	105	289
25	9.6	11.0	11.9	14.7	16.4	18.3	23.1	27.6	330	119	290

Table 108 - 5.2 Wind Speed Profiles for Probability Level of Exceedance, and Wind Directional Profiles for Year, Winter, and Summer. for Kopenhavn (Kuehenhavn/Jaegersb.) Denmark.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	7.9	9.3	10.2	13.2	14.8	16.9	21.8	26.4	317	318	268
1	8.0	9.4	10.4	13.4	15.1	17.2	22.2	26.9	254	257	254
2	8.2	9.6	10.6	13.7	15.4	17.6	22.7	27.5	267	266	259
3	8.7	10.2	11.2	14.5	16.3	18.6	24.0	29.1	269	258	267
4	9.7	11.4	12.5	16.1	18.2	20.7	26.7	32.4	269	267	267
5	11.2	13.2	14.5	18.7	21.1	24.0	31.0	37.6	269	256	270
6	13.1	15.4	16.9	21.9	24.7	28.0	36.2	43.9	272	269	272
7	14.9	17.5	19.3	24.9	28.0	31.9	41.2	49.9	272	268	274
8	16.1	19.0	20.9	26.9	30.4	34.5	44.6	54.1	273	270	274
9	15.2	18.0	19.9	26.0	29.5	33.7	43.7	53.3	273	269	274
10	15.5	18.4	20.4	26.6	30.1	34.3	44.6	54.3	274	269	279
11	14.7	17.4	19.3	25.1	28.5	32.5	42.3	51.5	274	267	279
12	12.7	15.2	16.8	22.0	24.9	28.4	37.0	45.1	281	258	281
13	10.7	12.7	14.1	18.5	21.0	24.0	31.2	38.1	274	257	282
14	10.2	12.2	13.5	17.7	20.1	23.0	29.9	36.5	280	258	283
15	9.9	11.9	13.1	17.3	19.6	22.4	29.2	35.6	280	257	283
16	9.9	11.8	13.1	17.2	19.5	22.3	29.0	35.4	273	254	282
17	11.8	13.6	14.9	18.7	20.9	23.6	30.0	36.1	273	251	281
18	10.8	12.0	12.8	15.4	16.8	18.6	22.8	26.8	274	242	281
19	8.6	9.5	10.0	11.8	12.7	13.9	16.8	19.6	272	237	279
20	7.8	8.5	8.9	10.4	11.2	12.2	14.6	16.8	284	211	279
21	8.2	8.9	9.4	10.9	11.8	12.9	15.5	17.9	284	179	278
22	9.0	9.9	10.5	12.4	13.5	14.8	17.9	20.9	269	169	277
23	9.8	10.8	11.5	13.7	14.9	16.4	20.0	23.5	327	166	280
24	10.1	11.1	11.9	14.2	15.4	17.0	20.8	24.4	327	168	280
25	10.0	11.0	11.8	14.0	15.3	16.8	20.6	24.1	327	169	281

Table 108 - 5.3 Wind Speed Profiles for Probability Level of Exceedance, and Wind Direction Profiles for Year, Winter, amd Summe, for Jan Mayen, Norway.

KM	50%	MEAN	68%	84%	90%	95%	99%	99.9%	TOT	SUM	WIN
0	8.3	9.7	10.7	13.8	15.5	17.7	22.8	27.7	329	300	358
1	8.6	10.1	11.1	14.3	16.1	18.4	23.7	28.8	298	266	27
2	8.8	10.4	11.4	14.7	16.6	18.9	24.4	29.5	269	256	298
3	9.2	10.8	11.9	15.3	17.3	19.6	25.4	30.8	269	256	298
4	9.9	11.6	12.8	16.5	18.6	21.1	27.3	33.1	268	267	284
5	10.9	12.9	14.1	18.3	20.6	23.4	30.2	36.6	267	257	272
6	12.2	14.4	15.8	20.4	23.0	26.2	33.8	41.0	257	256	268
7	13.5	15.9	17.5	22.5	25.4	28.9	37.3	45.2	267	258	283
8	14.4	16.9	18.6	24.0	27.1	30.8	39.8	48.3	268	257	283
9	13.9	16.3	17.9	23.1	26.1	29.7	38.3	46.5	258	253	272
10	13.4	15.8	17.4	22.4	25.3	28.8	37.1	45.0	266	255	272
11	13.1	15.4	17.0	21.9	24.7	28.1	36.2	43.9	268	258	283
12	13.0	15.3	16.9	21.8	24.5	27.9	36.0	43.7	268	253	286
13	13.3	15.5	16.9	21.6	24.2	27.4	35.0	42.3	268	252	286
14	12.6	14.7	16.0	20.4	22.8	25.9	33.1	39.9	268	253	284
15	12.0	14.0	15.3	19.5	21.8	24.6	31.5	38.0	268	244	285
16	11.5	13.4	14.6	18.6	20.8	23.5	30.1	36.3	266	241	287
17	13.0	14.8	16.0	20.0	22.2	24.9	31.4	37.6	268	244	294
18	13.5	15.2	16.3	19.9	21.9	24.4	30.3	35.9	267	236	288
19	12.2	13.6	14.6	17.7	19.4	21.6	26.7	31.5	268	229	290
20	11.5	12.8	13.7	16.6	18.1	20.1	24.8	29.2	258	212	289
21	11.7	13.0	13.9	16.8	18.5	20.5	25.3	29.8	257	210	297
22	12.5	14.0	15.0	18.2	20.0	22.2	27.5	32.5	256	207	296
23	13.4	15.1	16.2	19.8	21.8	24.2	30.1	35.7	252	206	298
24	13.9	15.6	16.8	20.5	22.6	25.1	31.3	37.1	243	206	295
25	13.4	15.0	16.1	19.6	21.6	24.0	29.9	35.4	243	206	298

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